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Formulation of β-Glucan fortified milk beverage and its sensory acceptability

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Abstract
Milk is regarded as complete food, as it contains all the essential nutrients. But the market still lacks good flavored and fortified milk beverages that have led an increase in the consumption of carbonated drinks. β-Glucan is a soluble dietary fibre that imposes several health benefits because of its gel-forming ability and imparting viscosity to the meals. It helps in regulation of appetite and gives a feeling of satiety. This study was done to evaluate the processing methods to maximize the stability and sensory acceptability of β-Glucan in β-Glucan fortified milk beverage.

Keywords: β-Glucan, stability, heating process, maltodextrin, sensory acceptability

1. Introduction
Milk plays an important role in human nutrition by providing all the essential ingredients required for the metabolism of the human body system. The average composition of milk is water 87.20%, protein 3.50%, fat 3.70%, lactose 4.90% and ash 0.70% (Byron *et al*., 1974) [1]. Milk is also good source of minerals such as, calcium, phosphorus, and fat-soluble vitamins (A, D, E and K) (Kajal *et al*., 2012) [6] which makes milk a complete food (Sharma *et al*., 2016) [16]. Milk is the base for the preparation of all of the dairy products (Okenova *et al*., 2010) [12]. When milk is either fortified or enriched, it could complete the nutritional requirements of the people (Krupa *et al*., 2011) [7]. Especially, cow milk posses multiple benefits along with its nutritional value (Mendelson, 2011) [10].
β-Glucan is structural polysaccharide found abundantly in the cell wall of endosperm and aleurone layers of oat, barley, wheat and rye (Charles and Louise, 2005; Lazaridou *et al*., 2008) [3, 9]. It is naturally present in the cereal grains and fungal mass and possess biological response modifiers that are physiologically active compounds (Vetvicka and Vetvickova, 2017) [18]. β-Glucans are heterogenous group made up of D-glucose monomers linked by glycosidic bond, i.e. (1-3)- β, (1-4)- β or (1-6) β (Stier *et al*., 2014) [17]. β-Glucans are also conferred as water-soluble polysaccharides or, popularly recommended by scientists as viscous polysaccharides, i.e. non-digestible polysaccharides. Being a soluble dietary fibre, it has gained tremendous attraction towards its incorporation in food products.
The health benefit of β-Glucan lies in the fact that it increases the viscosity when mixed with liquids (Rebello *et al*., 2014) [15] and makes a gel-like structure. This property of β-Glucan has been positively associated in the prevention of many health-related severe diseases like, cancer, cardiovascular disease, lowering of glycemic index, diabetes, obesity and hypertension (Jirdehi *et al*., 2013) [5]. It has also been reported that β-Glucan helps in the regulation of appetite, i.e. increased stomach distension, gastric emptying and delayed intestinal transit (Kristensen and Jensen, 2011) [8]. Moreover, the increased viscosity of the intestinal content delays the absorption rate of nutrients as well as increases the transit time (Malijaars *et al*., 2008) [11].
The fortification of β-Glucan in milk is quiet difficult in milk due to the consequence of phase-separation. To avoid this difficulty, potential dairy stabilizers could be used such as, κ-carragenan, Maltodextrin, gum Arabic, gum acacia; etc. or a combination of any of these. Maltodextrin is a simple carbohydrate that is easily digestible and gets converted to instant energy (Parikh *et al*., 2014) [13]. It is being used extensively in food and dairy industries due to its emulsifying, texturizing, stabilizing, gelling and non-crystallizing properties.
Fortified, or functional beverages are becoming a part of the healthy lifestyle for the people all around the world; but fibre enriched milk beverage is still lacking in the market. Incorporation of dietary fibres is being done on a large scale into drinks, juices and smoothies. There is still lack of research about incorporating dietary fibre into milk beverages. Therefore, this research was planned to study the fortification of β-Glucan and its stability in the milk beverage along with its sensory acceptability.

2. Materials and Methods

The present work was carried out in the laboratory of Department of Animal Husbandry & Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. β-Glucan fortified milk beverage was manufactured using cow milk, β-Glucan, Maltodextrin, sugar and vanillin powder.

2.1 Collection of raw materials

Cow milk was procured from the Dairy Farm of the Department of A.H. & Dairying, IAS, BHU. β-Glucan was procured from Kuber Impex Ltd., Indore. Sugar was purchased from the local market of Varanasi. Maltodextrin was obtained from the laboratory. Vanillin powder was procured from International Flavors and Fragrances, New Delhi.

2.2 Preparation of fortified milk beverage

The fortification of β-Glucan in milk was made using two processing methods, i.e. single stage heating method (Fig.1) and two-stage heating method (Fig.2) (Bangari, 2011.) [2]. The level of all the ingredients was selected on the basis of preliminary trials. For 100 ml of cow milk, sugar was 4%, Maltodextrin 7%, vanillin powder 1.0% and β-Glucan 3.0% (Chatterjee and Patel, 2016) [4].

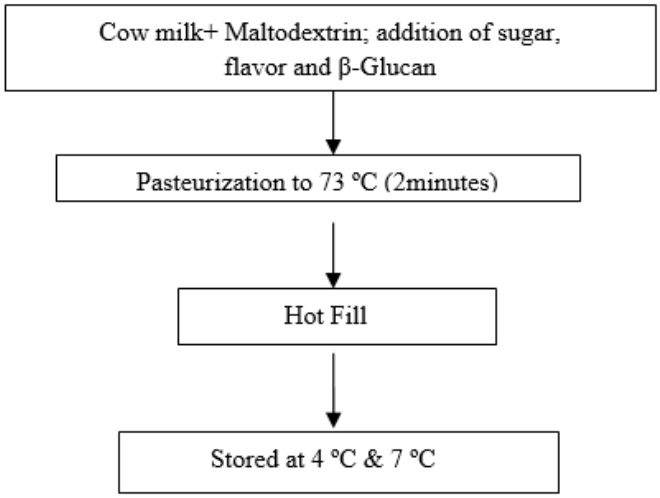

Fig 1: Single-stage heating process

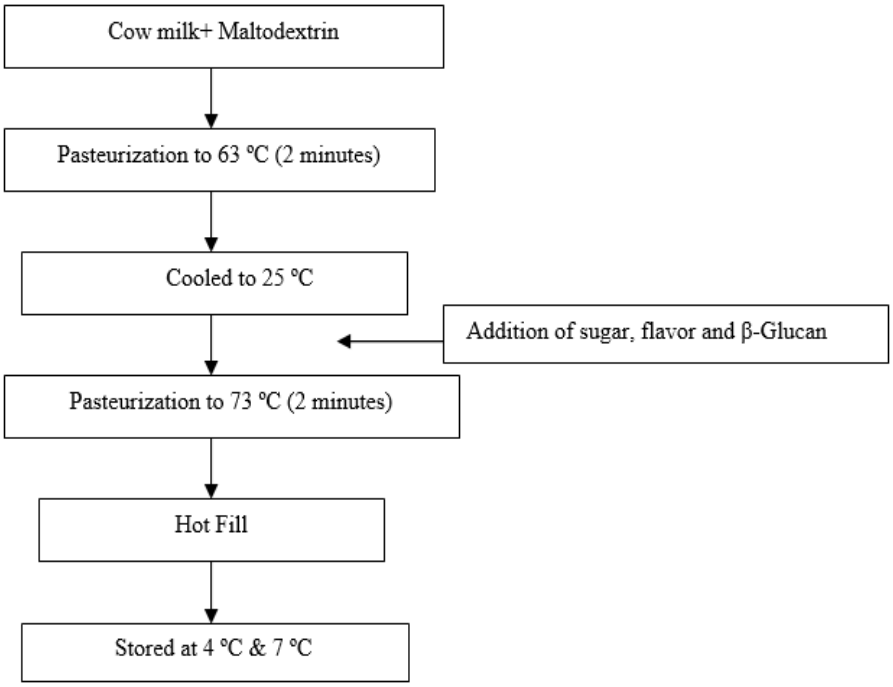

Fig 2: Two-stage heating process

2.3 Storage of β-Glucan fortified milk beverage

β-Glucan fortified milk beverage was hot filled in glass bottles and stored at 4 ºC and 7 ºC for a period of 60 days that was analysed at a time interval of ten days.

2.4 Sensory acceptability of β-Glucan fortified milk beverage

The sensory analysis of β-Glucan fortified milk beverage was carried out at 4 ºC and 7 ºC by a semi-trained panel of 9 judges including the members from staff and students of the Department of Animal Husbandry & Dairying at Banaras Hindu University, Varanasi, India (Rathor *et al*., 2016) [14]. The judges were asked to review the samples as acceptable or non-acceptable on the basis of physical appearance and mouthfeel.

3. Result and Discussion

3.1 Comparison of the heating protocols

The single-stage heating method, i.e. simultaneous addition of all the ingredients showed less stability to β-Glucan as compared with the two-stage heating method. This is because in single-stage heating method the complete hydration of maltodextrin did not take place with milk and lead to the phase-separation. At the end of 40th day, phase separation was completely observed in the sample stored at 7 ºC; whereas for the sample stored at 4 ºC, phase separation was observed at the end of 60th day (Table 1).

In case of two-stage heating method, i.e. separate addition of the ingredients, the samples showed stability till the end of the 60th day (Table 2). This is because the separate addition of maltodextrin allowed its complete hydration in milk which further stabilized β-Glucan. This result is in agreement with

the findings of Bangari (2011) [2] and Chatterjee and Patel (2016) [4] who also observed the same result with the use of κ-carrageenan.

3.2 Sensory acceptability of the fortified milk beverage

The sensory acceptability of β-Glucan fortified milk beverage was evaluated on the basis of physical appearance and overall acceptability. Table 1 & 2 depicts the data for sensory acceptability of β-Glucan fortified milk beverage made with two processing protocols and stored at 4ºC and 7ºC. Milk beverage made by simultaneous addition of ingredients was found to lose its acceptability by the end of 40th day for the sample stored at 4 ºC; whereas the acceptability decreased after 30th day for the sample stored at 7ºC (Table 1). Off-flavor of β-Glucan was sensed which highly decreased its acceptability. Milk beverage made by separate addition of ingredients remained acceptable till the end of 60th day (Table 2). No off-flavor due to β-Glucan was felt upon consumption. Similar results were also found by Bangari (2011) [2] that separate addition of ingredients in the formulation of milk beverage gave more consumer acceptability as compared with the simultaneously added ingredients procedure.

Table 1: Sensory acceptability of β-Glucan fortified milk beverage made by single-stage heating process

Days	Sensory Acceptability			
	4ºC	Acceptable/Non-acceptable	7 ºC	Acceptable/Non-acceptable
0	Completely Liquid, No phase separation	Acceptable	Completely Liquid, No phase separation	Acceptable
10	No phase separation	Acceptable	No phase separation	Acceptable
20	No phase separation	Acceptable	No phase separation	Acceptable
30	No phase separation	Acceptable	Slightly separation observed	Still acceptable
40	No phase separation	Acceptable	Two separated layers as well as off-flavor observed	Rejected
50	Slightly separation observed	Acceptable	Sample discarded	
60	Two separated layers observed	Not acceptable, Rejected		

Table 2: Sensory acceptability of β-Glucan fortified milk beverage made by two-stage heating process

Days	Sensory Acceptability			
	4ºC	Acceptable/Non-acceptable	7ºC	Acceptable/Non-acceptable
0	Completely Liquid, No phase separation	Acceptable	Completely Liquid, No phase separation	Acceptable
10	No phase separation	Acceptable	No phase separation	Acceptable
20	No phase separation	Acceptable	No phase separation	Acceptable
30	No phase separation	Acceptable	No phase separation	Acceptable
40	No phase separation	Acceptable	No phase separation	Acceptable
50	No phase separation	Acceptable	No phase separation	Acceptable
60	No phase separation	Acceptable	No phase separation	Acceptable

4. Conclusion

Therefore, it is concluded that the two-stage heating regime could be effectively used to make the stability of β-Glucan with the addition of Maltodextrin in milk. The fortified milk beverage could be preserved for 60 days without any phase separation.

5. References

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